Claims

CLAIM 1. Procedure for reducing the concentration of ammonia gas in a room, wherein:

[2] the room includes a source of ammonia, which is effective to emit ammonia into the room at a large enough rate, in relation to the size of the room, and to the degree of ventilation of the room, if the air in the room were left untreated, to drive the concentration to a level at which remediation is required;

[3] the procedure includes:-

[4] providing a hydroponic apparatus, containing a body of hydroponic water, which includes:-

- a mass of plants, having substantial green foliage;
- a matrix, to which portions of the said green plants are mechanically attached;
- a nutrient station;
- a falling curtain of droplets of the hydroponic water;

[5] passing the ammonia-contaminated air in the room through the said falling curtain, again and again on a re-circulating basis, whereby a major proportion of the ammonia in the air goes into solution in the hydroponic water;

[6] passing the hydroponic water containing the dissolved ammonia/ammonium over the matrix, and over the portions of the green plants that are attached to the matrix, again and again on a re-circulating basis, in such manner that:-

- viable colonies of microbes become established on the portions of the green plants that are attached to the matrix, and are wetted by the hydroponic water;
- the dissolved ammonia/ammonium undergoes oxidation, by microbial action thereof;
- the dissolved ammonia/ammonium is thereby broken down, the nitrogen therefrom being assimilated into the tissue of the green plants;

[7] so arranging the size and efficacy of, and so operating, the hydroponic apparatus that the concentration of ammonia gas in the room is maintained below the level at which remediation is required.

Claim 2. Procedure of claim 1, wherein:

[2] the source of ammonia is effective to emit ammonia into the room at a large enough rate, in relation to the size of the room, and to the degree of ventilation of the room, to drive the concentration to more than ten milli-grams of ammonia per cubic metre of air in the room, and, if the air in the room were left untreated, to keep the air in the room at that concentration;

[3] and the procedure includes so arranging the size and efficacy of, and so operating, the hydroponic apparatus as to maintain the concentration of ammonia gas in the room below ten milli-grams of ammonia per cubic metre of air.

Claim 3. Procedure of claim 1, wherein the said green plants include plants having foliage that remains undamaged by continuous exposure to ammonia concentrations of thirty milli-grams of ammonia per cubic metre of air.

Claim 4. Procedure of claim 1, wherein the said green plants include plants having foliage that is characterised as thick and fleshy, and as having a waxy surface.

Claim 5. Procedure of claim 1, wherein the said green plants include plants that have the characteristic, when attached into a hydroponic matrix, and when supplied hydroponically with nutrients, of co-existing alongside other plants, and of maintaining a substantially complete coverage of the surface area of the matrix, substantially without leaving a gap between the plants, over a prolonged period of time.

Claim 6. Procedure of claim 1, wherein the said green plants include plants having flowers and roots.

Claim 7. Procedure of claim 1, wherein the said green plants include at least one of Peperomia or Hoya.

Claim 8. Procedure of claim 1, wherein:

[2] the matrix, with the green plants attached thereto, is so structured as to be porous and permeable to the passage of air through the matrix;

[3] the apparatus is so arranged that the matrix lies in an upright configuration;

[4] the procedure includes creating the said curtain of hydroponic water droplets by supplying the hydroponic water to a top level of the matrix, and by so arranging the matrix as to enable the hydroponic water to drip and trickle downwards, under gravity, through the matrix;

[5] and the procedure includes passing the ammonia-contaminated air horizontally through the wetted matrix.

Claim 9. Procedure of claim 8, wherein:

[2] the apparatus includes a plenum;

[3] a front structure of the plenum comprises the matrix;

[4] a rear structure of the plenum comprises an air container, located behind the matrix;

[5] the plenum is so structured as to receive air in only through the front structure of the plenum, through the matrix;

[6] the matrix, with the plants attached, is exposed to the ammonia-contaminated air in the room;

[7] the procedure includes operating the fan to draw air into the plenum from in front of the matrix, in through the matrix;

[8] the procedure includes then exhausting the air from the plenum back into room.

Claim 10. Procedure of claim 9, wherein the hydroponic apparatus is so arranged that substantially the whole area of the matrix through which ammonia-contaminated air is drawn into the plenum is kept constantly dripping wet with the hydroponic water.

Claim 11. Procedure of claim 10, wherein:

[2] the matrix is arranged to slope in a near-but-not-quite vertical configuration;

[3] the slope angle to the vertical is large enough that water supplied to the front surface of the matrix at the top of the matrix, as it trickles and drips down through the matrix, is urged by the slope angle to pass into the thickness of the matrix, and to drip out from the rear surface at the bottom of the matrix;

[4] the slope angle of the matrix is close enough to the vertical that the water drips down through the matrix, from top to bottom, substantially evenly throughout the thickness.

Claim 12. Procedure of claim 1, wherein:

[2] the matrix is of a fibrous plastic material, in which the fibres are matted together to form a densely-packed mat;

[3] the said plastic material is of such nature that the material remains substantially unaffected, mechanically or chemically, or in any way, by the hydroponic water, over a period of years;

[4] the plastic material is of such nature as to promote the establishment and retention of viable colonies of microbes thereon;

[5] and preferably the plastic material is polyester.

Claim 13. Procedure of claim 1, wherein:

[2] the matrix comprises a mat of fibrous plastic material, the fibres having a thickness of 0.2 mm or more;

[3] the mat has a thickness of between one cm and five cm, and preferably between 1½ and three cm.

Claim 14. Procedure of claim 1, wherein the matrix comprises a mat of fibrous plastic material, having a density characterised in terms of the airflow resistance of the mat, as follows:

[2] when a flow of air of 200 litres per second is passed through a section of the mat that is one square meter in area, and one centimetre thick, the pressure differential through the thickness of the mat should be not less than 0.2 and not more than 1.0 centimetres of water.

Claim 15. Procedure of claim 1, wherein:

the curtain of droplets of the hydroponic water is physically separated from the matrix and from the green plants attached thereto;

the procedure includes arranging the passage of the ammonia-gas-contaminated air through the said curtain in such manner as to cause the ammonia to go into solution in the hydroponic water;

the procedure includes arranging the passage of the ammonia-gas-contaminated air through the said curtain in such manner as to keep contact between the green plants and the ammonia below toxic levels relative to the plants.